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# EAST AFRICAN AGRICULTURAL RESEARCH STATION, AMANI

## SECOND ANNUAL REPORT, 1929—30.

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## EAST AFRICAN AGRICULTURAL RESEARCH STATION, AMANI.

**Report for the period 1st April, 1929, to 31st March, 1930.**

### STAFF LIST.

Director—W. Nowell, C.B.E., D.I.C., F.L.S.
Entomologist—C. B. Williams, M.A., F.E.S. (Resigned 3rd July, 1929.)
Plant Pathologist—H. H. Storey, M.A., Ph.D.
Soil Chemist—G. Milne, M.Sc., F.I.C.
Biochemist—R. R. Le G. Worsley, A.R.C.S., B.Sc., Ph.D.
Plant Physiologist—F. J. Nutman, A.R.C.S., M.Sc., D.I.C.
Plant Geneticist—L. R. Doughty, B.Sc., (Agric.).
Superintendent of Plantations—F. M. Rogers.
Secretary and Librarian—R. E. Moreau.
Botanist—P. J. Greenway.
Assistant Superintendent of Plantations—K. E. Toms.
Assistant Secretary and Librarian—W. M. Nutter.
Manager, Kwamkoro Coffee Estate—E. M. Nicholl.
Engineer-Mechanic—J. I. Bradshaw.
Engineer (Temporary)—T. V. Greenwood.
Laboratory Assistant (Pl. Path.)—R. F. W. Nichols.
Laboratory Assistant (Soil Chem.)—W. E. Calton, B.A.
Stenographer—(Miss) K. Rushworth.

### STAFF CHANGES.

Mr. C. B. Williams, Entomologist, left Tanga on the 8th of April, 1929, to go on leave. He resigned on the 3rd of July to take up an appointment in the University of Edinburgh. A successor to the post has not yet been appointed. Mr. J. I. Bradshaw, Engineer Mechanic, ceased duty on the termination of his agreement on the 24th of March, 1930. His duties have been taken over by Mr. T. V. Greenwood, Temporary Engineer, who will succeed to the post on the termination of Mr. Bradshaw's leave. Mr. L. R. Doughty was appointed Geneticist to succeed Mr. G. F. Clay, and assumed duty on the 1st of October, 1929.

The following new appointments were made :—

Mr. R. F. W. Nichols, Laboratory Assistant to Plant Pathologist, assumed duty 10th August, 1929.

Mr. W. M. Nutter, Assistant Secretary and Librarian, assumed duty 2nd October, 1929.

Mr. W. E. Calton, B.A., Laboratory Assistant to Soil Chemist, Assumed duty 16th March, 1930.

### Leave.

The following officers went on leave during the year :—

Mr. C. B. Williams, Entomologist, 8th April, 1929.

Mr. K. E. Toms, Assistant Superintendent of Plantations, 20th October, 1929.

Captain E. M. Nicholl, Manager, Kwamkoro, 1st February, 1930.

Dr. H. H. Storey, Plant Pathologist, 9th March, 1930.

Mr. R. E. Moreau, Secretary and Librarian, 16th March, 1930.

# REPORT OF THE DIRECTOR.

## PROGRESS OF THE STATION.

The First Annual Report* of the reorganized Station recorded the progress made with the building and reconstruction of laboratories and staff quarters, the making and improvement of roads, and the clearing of the plantations from the encroaching forest. During the second year the new quarters have been furnished and occupied, and the fitting of the laboratories has progressively advanced, so that by the end of the year the equipment of the Station for the purposes at present in view is virtually complete. The only important item outstanding is the provision of electric current, and this is expected to be available within a few weeks of the end of the year under report. An ample margin of laboratory accommodation exists to allow for extensions of the staff or for the accommodation of visiting workers. Separate laboratory groups are provided for Soil Science, Plant Pathology, Entomology, and Biochemistry, while Plant Physiology and Systematic Botany occupy together the largest of the German buildings. The library has been completely rearranged and the collections of books and papers put into working order. Details of the work undertaken during the year are presented in the form of progress reports signed by the officers immediately concerned. The period of reorganization may now be considered to be at an end and future reports should be concerned only with the progress of research on the subjects selected for investigation. If it is considered that two years is a long time to be occupied with constructional work it should be remembered that all the complicated business of providing for scientific research on modern lines has had to be carried out by the staff and with the resources of the station itself unaided by external organizations either public or commercial.

## FUNCTIONS OF CENTRAL RESEARCH STATIONS.

The functions of the proposed chain of Imperial Agricultural Research Stations, of which the Agricultural College in Trinidad and the East African Research Station at Amani are the first members, were fully discussed at the Imperial Agricultural Research Conference held in London in 1927. The recommendations of the Conference were endorsed by the Committee on the Colonial Agricultural Service appointed by the Secretary of State for the Colonies under the chairmanship of Lord Lovat, and the development of the Amani Research Station has been governed by the policy which was thus established. While this is generally understood in official circles there is continually recurring evidence of the need for an explanation of the principles adopted to be given to the general public. The following quotation from the Report of the Committee

* Colonial No. 50 .

referred to above should serve to make the position clear (Cmd. 3049, *Colonial Agricultural Service*, 1928, *pages* 17–18) :—

" The recommendations of the Imperial Agricultural Research Conference regarding the functions of a Central Research Station are set out in the following paragraphs from their Report :—

' They (i.e., the Conference) consider :—

' (i) that the establishment of central tropical and sub-tropical research stations should be governed primarily by the ascertained needs of Empire research in particular fields of agriculture, rather than by considerations of geographical distribution ;

' (ii) that stations for dealing with problems suitable for such treatment should be located in territories affording specially advantageous conditions for the study of each such problem ;

' (iii) that the stations should, in the main, confine themselves to " long range " and " wide range " research, i.e., that they should concentrate on (*a*) problems requiring more prolonged research work than can normally be expected from the technical staff of any single administrative department ; (*b*) problems arising in more than one territory of the Empire towards the solution of which the comparative method may be expected to make an effective contribution.

' The Conference desire to emphasize the importance of preventing the establishment of a central research station from being allowed to impair or replace the scientific work properly undertaken by the Agricultural Department of any Government in its proximity. They conceive the work of such stations as a reinforcement of that of the Agricultural Departments, and in no sense as a substitute for their work. The work undertaken by a central research station will from time to time enable it to afford valuable advice to Agricultural Departments in its neighbourhood, but they do not consider that it should be regarded as a function of a central station as such to provide such advice, except as the direct result of its research activities. This conclusion, however, should not be taken as debarring a central station, in special conditions such as those of the West Indies, from being treated as a convenient base of operations for a travelling advisory staff.

' They do not consider that a research station, as such, should be expected to undertake any teaching work, except in so far as the advanced instruction of a limited number of post-graduate students can be undertaken with advantage to the research work in progress. In making this recommendation they do not overlook the need, in certain parts of the Empire, and notably in West Africa, for the provision of additional teaching facilities, designed primarily to enable native students to become qualified assistants in research work, whether at a central research station or in an Agricultural Department, but they consider such provision to fall within the sphere of other Government services.'

" With these recommendations we find ourselves in general agreement.

" We consider it important that Central Research Stations should not be unduly affected by local administrative considerations, but, at the same time, it is natural that they should take in hand subjects particularly affecting their own group. While any attempt rigidly to organize research is obviously to be deprecated, it is, we think, clear that local requirements should influence the general direction in which investigations at a group institution can most usefully be prosecuted.

" In this connection we should like to stress the importance of the closest touch being maintained between the Central Research Station and the ordinary agricultural activities of the Colony or group of Colonies in which it is situated. As was recognized by the Research Conference, the work of such stations should be regarded as a reinforcement of that of the local Agricultural Departments, and

in no sense as a substitute for it ; for instance, whereas the aim of an Agricultural Department in carrying out breeding and selection work in the case of such crops as rice, coconuts, tea, coffee, sugar, cotton, etc., should be to secure higher yield, better adaptation, or superior quality, the aim of a Central Research Station for similar crops should be to discover the basis on which these characters are founded and the methods of their inheritance."

There is one of the original functions of the Amani Station which, although it lies outside the boundaries stated, is considered desirable to be continued, namely, the distribution of plants and seeds. There exists at Amani a collection, unrivalled in the country, of plants, especially trees, of economic interest. There is an active demand for seeds both directly and through Departments of Agriculture, and the maintenance of exchange relations facilitates the inflow of useful plants from other countries. The service is one that can quite well be maintained without interfering with research work and is financially self-supporting.

## THE SITUATION OF THE STATION.

There are two criticisms of the selection of Amani as the site for a central research station which have become so firmly established even in responsible quarters in East Africa and in England that they demand serious attention. One is that the situation is not representative of East African agricultural conditions, and the other that it is inaccessible. The first would be true of any site that could be selected. In a country which ranges in altitude for agritural purposes from sea level to near 10,000 feet, and annual rainfall from under 10 to over 100 inches, it is physically impossible for one station anywhere to represent more than a comparatively narrow range of the conditions. Amani is as good as any place in this respect and far better than most. It is within working distance of the plains and therefore of the strictly tropical crops, including sisal, while it is high enough to provide normal conditions for tea and coffee. It is within a day's journey of Zanzibar on the one hand and of Moshi, Arusha, and Ngare Nairobi on the other. This gives a range from coconuts to wheat. A site on the coastal plain or one on the interior plateau would lose touch with either one kind of agriculture or the other. It should not be forgotten that in the original allocation the contribution of Zanzibar was equal to that of Kenya or Uganda.

In spite of the frequency of the criticism no alternative site seems ever to be definitely suggested and it would have needed very important advantages to offset the existence at Amani of roads, buildings and equipment which would cost not less than £100,000 to reproduce elsewhere, to say nothing of the availability of long-established plantations of important crop plants.

The question of the accessibility of Amani is purely a matter of comparison. The main roads of Tanganyika, and the same is true

of Kenya, are frequently impassable in the rains and this of course affects any place which has to be approached over them. So far as the connection of Amani with the railway at Muhesa is concerned it has in wet weather the advantage of a hill road over any place of which the communications lie wholly or in part across the flats. The road may be difficult and it may have, to an unaccustomed visitor, the appearance of being dangerous, but it is practically never impassable. Moreover the branch railway to Sigi, when it is in operation, will deliver goods and passengers at the boundary of the Amani plantations and on to an all-weather road. In fine weather there is no particular difficulty in reaching Mombasa on the one hand or Moshi on the other in a single day and the journey to Tanga is usually made in between two and three hours.

## RESEARCH POLICY.

The research programme published in the first Annual Report is obviously much too wide in its scope to be covered by the present staff and resources of the Station. A selection has to be made of the objects to be immediately pursued and the lines which this selection has so far taken are indicated in the reports of the research officers. Since in practice it is difficult to define the boundaries between the work prescribed for the Station and that of the scientific officers of the Departments of Agriculture it is necessary that agreement should be reached by conference. A meeting of the Directors of Agriculture for this purpose is likely to take place towards the end of 1930 and the Director of the Station has been instructed to discuss the subject with the Colonial Advisory Council of Agriculture in London while on leave during the summer. Meanwhile notable progress has been made in this direction so far as Tanganyika Territory is concerned. The Acting Director of Agriculture visited Amani in December, 1929, and a full discussion of the relationship between the Station and the Department resulted in the submission by the Acting Director to the Governor of a series of constructive proposals providing for the co-ordination of the work of the two organizations at all points of contact, and including a proposal for two prospective officers of the Department to be attached for some time to the Station. Visits were also paid to Amani by the Director and Assistant Director of the Zanzibar Department and a complete understanding exists with regard to relations with that Dependency. Towards the end of the year under report an official visit was paid by the Soil Chemist of the Uganda Department. Preliminary discussion with a view to co-ordination in certain matters of common interest has also taken place with the officers engaged in Tsetse Research in Tanganyika Territory. The visit of Dr. Storey to Nyasaland resulted in warm appreciation of his services from both official and unofficial sources. The completion of the main work of reconstruction at Amani should make it possible from

now onwards to carry out the recommendations of Lord Lovat's Committee on the Colonial Agricultural Service that "the Director and other officers should do as much travelling as possible in order to keep the Central Research Station in close touch with ordinary agricultural activities in the group of Colonies and with local research work."

*Sisal Research.*

A subject which requires careful consideration is that of botanical and agricultural research in relation to the sisal industry. The negative results so far obtained from a search of agricultural literature seem to show that this is practically a clear field, while at the same time there is no information that any notable difficulties have arisen in the cultivation of the crop. It is unlikely however that sisal will long remain in so exceptional a position among agricultural industries, and advantage should be taken of the present opportunities to acquire information which will inevitably be needed in the future. The Station from an early date has been in touch with the East African (late Kenya) Sisal Growers' Association, and in the absence of an organized body representing the Tanganyika growers has made individual approaches to some of the more important of these for the purpose of obtaining their views. Nothing definite has emerged and it seems desirable that a meeting representative of the Companies and the Departments of Agriculture concerned should be held to discuss the whole subject including the desirability of the establishment of a special experiment station. Meanwhile the fundamental question of the extent of the variation to be found in sisal plants grown from seed is under investigation at Amani, and a nursery of some 4,000 plants from seed kindly supplied through the Kenya Sisal Growers' Association is already in existence. The importance of seedling strains in the cultivation of sugar-cane, at one time equally dependent on vegetative propagation, illustrates the potential interest of work on these lines.

## SPECIAL CROPS.

*Tung Oil Production.*

Last year the establishment of widely distributed plots of *Aleurites Fordii*, the tree which yields Tung Oil, was recorded. The object in view is the observation of the response of this plant to East African conditions with a view to its recommendation as the basis of a possible new industry should the results justify this course. As the tree takes some four or five years to come to fruiting age, an early decision cannot be expected. During the year under review Tung Oil production was the subject of considerable publicity and an insistent demand arose from many parts of East Africa for large supplies of seed. Planters are not disposed to wait on the slow results of scientific experiment but are prepared to take chances. Unfortunately there does not appear to exist at present any available

source for more than a minute fraction of the quantities of seed demanded. The distribution of this is now in the hands of the Director of the Royal Botanic Gardens, Kew, working through the Departments of Agriculture or of Forestry in the dependencies concerned. The plants distributed by this Station in Tanganyika Territory at elevations from sea level to nearly 5,000 feet and in different types of soil have not so far shown the disposition for rapid growth reported from some other places. In the plots at heights from 1,500 to 3,500 feet in the Amani district the plants, while remaining perfectly healthy in appearance, have so far developed slowly and are less than two feet high. Reports on a series of plots established on Kilimanjaro suggest that even in the rich volcanic soil of that mountain progress is not very much faster. It is still hoped that the plants will break into more rapid growth. Until their eventual fruiting capacity is revealed no final conclusion can be reached.

*Cinchona.*

An outstanding feature of the Amani plantations is the existence of a considerable area under Cinchona trees of various species and ages. The original German plots are ratoon growths, the first crop having been cut during the war. The newer plots are about seven years old and well-developed. During the year a series of determinations of alkaloid content has been made by the Biochemist and the results, together with a description of the condition of the plots, formed the subject of a report which has been submitted to the Secretary of State for the Colonies, whose decision is awaited as to the desirability of further investigation of the possibilities of quinine production in East Africa. Conditions at Amani have been demonstrated to be suitable for this work should it be decided to be worth pursuing.

*Cover Crops.*

Exceedingly promising results have been obtained with a number of species of plants, both local and imported, under trial as long and short-term cover crops. These should prove to have great usefulness on coffee and tea estates and might very well be introduced in some districts as a first stage in the improvement of the native systems of shifting cultivation. As soon as sufficient seed has been accumulated from the plots first established large scale trials will be made at Kwamkoro. Numerous further introductions of promising species have recently been made.

## CONFERENCES.

*Soil Erosion.*

As an outcome of the concern aroused in certain members of the Tanganyika Government Services by the evidence of destructive and rapid soil erosion taking place in the semi-arid districts of the

Territory, an informal conference was held in May, 1929, at the headquarters of the Geological Department at Dodoma, and attended by scientific and administrative officers from several departments. Amani was represented by the Director, who was elected to preside over the meetings, and by the Soil Chemist, and the Superintendent of Plantations. A report was prepared which gained the support of the Heads of Departments concerned and was submitted to His Excellency the Governor. The formation of a standing committee to deal as occasion arises with the many phases of this most important subject was advocated and it is understood that action on these lines is contemplated. The observed wide variations among African soils in their liability to rapid erosion has been noted as an important subject for investigation.

*Pan-African Agricultural Conference.*

In August, 1929, the Director attended the meetings of the Pan-African Agricultural Conference at Pretoria. Much information was gained with regard to the various lines of agricultural research which are being pursued in South Africa and valuable contacts were made with the officers concerned, and with the delegates from other regions. Some tentative efforts were made by the Conference to secure greater co-ordination of the work of the various countries represented.

The opportunity was taken of attending the meetings of the Agricultural Section of the British Association which was also assembled in Pretoria.

## AMANI PLANTATIONS.

*Kwamkoro Coffee Estate.*

The estimate given in the previous Report as to the effects of locust damage on the coffee crop was only too completely confirmed. Instead of a crop of at least 80 tons, which the yields of undamaged plantations in the district show to have been a reasonable expectation, the yield realized fell short of 30 tons. At the time of writing, while locust invasions have not recurred, crop prospects over the district in general are much less promising than they were last year. It is increasingly evident that skilled handling will be needed to secure a satisfactory average annual return.

The shortage of crop has reduced to a minimum the resources available for the work of regeneration. A serious beginning has however been made with heavy reduction of shade, pruning of overgrown trees, stumping back the many trees which had become hopelessly irregular in shape, and supplying vacancies. The principal difficulty of management is caused by the rapid development and luxuriance of the undergrowth, which is at any rate evidence of the fertility of the soil and of the suitability of the conditions for vegetative growth.

*Low-Level Station at Tengeni.*

As soon as the restoration of traffic on the Sigi Railway supplies direct access, it is proposed to open up the low-level station previously attached to Amani, which is suitable for work with sisal, cotton, citrus, and the tropical food crops. With this end in view botanical and soil surveys have been made and have provided information which will be needed in laying out the sub-station.

*Provision of other Sub-stations.*

Action with regard to the provision of facilities for observation and experiment under a wider range of conditions of soil and climate is waiting upon the decisions of the Colonial Development Advisory Committee on the proposals put forward by the Government of Tanganyika Territory for a series of experiment stations to deal with the principal export crops. If these are established it should be possible to arrange for them to serve the purposes of fundamental research in addition to their more immediate object of providing information for the direct benefit of the agricultural community.

## VISITORS TO THE STATION.

Amani attracted a large number of visitors during the year, who showed much interest in the progress of the Station and were impressed by the beauty of its surroundings. Those coming from overseas included Sir Samuel Wilson (Colonial Office), Sir Daniel Hall (Ministry of Agriculture), Sir Robert Grieg (Scottish Department of Agriculture), Professor Hitchcock (Department of Agriculture, Washington), Mr. A. D. Cotton (Royal Botanic Gardens, Kew), Major Walter Elliott, M.P., and Mr. A. Ryan (Empire Marketing Board), Miss Glynne (Rothamsted), Mr. R. H. Morrison (Rhodes Trustees), Professor Julian Huxley (Kings College, London), Professor Hummel (Giessen), Dr. Hinsdorf, Mr. Norton Breton (Imperial Institute), and the Right Honourable Neville Chamberlain, M.P. Official visitors from the East African Dependencies included Mr. A. Walter (Statistician to the Governors' Conference), Mr. S. B. B. Mc Elderry (Deputy Chief Secretary, Tanganyika Territory), Mr. P. E. Mitchell (Commissioner for Native Affairs, Tanganyika Territory), Mr. U. J. Moffatt (Department of Agriculture, Northern Rhodesia), Mr. V. H. Kirkham, Director, Mr. A. Barnes, Deputy Director, and Mr. L. W. Raymond, Chemist (Department of Agriculture, Zanzibar), Mr. H. Wolfe, Director, Mr. A. Ritchie, Entomologist, Dr. Wallace, Mycologist, and Mr. R. Staples, Economist (Department of Agriculture, Tanganyika Territory), Mr. C. Gillman (Chief Engineer, Tanganyika Railways), Dr. Martin (Department of Agriculture, Uganda). Among the many unofficial visitors to the Station were included a considerable number of plantation managers and settlers from Tanganyika Territory and a few from Kenya.

W. NOWELL,
*Director.*

## REPORT OF THE PLANT PATHOLOGIST.

During the greater part of the year under review, satisfactory p ogress has been possible along the lines of work laid down in the research programme of the Station. These are primarily the investigation of virus diseases, and secondarily the study of particular diseases of economic crops in East Africa.

The early difficulties of accommodation and equipment have now been largely overcome. The laboratory is fully fitted out with furniture, gas, water, and specialist equipment. The insect-proof greenhouse, made by Messrs. Mackenzie and Moncur of Edinburgh, has been erected and has worked most satisfactorily under Amani conditions. Reasonable temperatures have been maintained without recourse to the electric fans with which each chamber is fitted. The space available, however, is already overcrowded and an additional unit to the projected range of greenhouses is needed.

The staff of the section has been increased by the appointment of Mr. R. F. W. Nichols as Laboratory Assistant. Continuity of work during periods of absence of the Pathologist on leave or safari is therefore assured. Progress, however, in the work proposed can only be slow until the scientific staff is considerably increased over its present strength of one. Not only are many lines of work within the projected virus investigations shelved for the present for lack of workers, but there is room for a mycologist for work upon problems of diseases caused by fungi and bacteria.

### VIRUS DISEASES OF PLANTS.

The need for a better understanding of plant virus diseases is widely recognized by those dealing with the diseases of agricultural crops. The group embraces some of the most serious plant diseases known and is represented in every country where agriculture is practised. The Imperial Agricultural Research Conference, 1927, recognized the importance of the virus problem by making the recommendation that funds be provided for the more extended study of the fundamental nature of virus diseases in plants.

The object of the investigations of the Pathological Section of this Station is ultimately the elucidation of the nature of virus diseases. In view of the almost complete failure of the direct attack upon this problem—i.e., by microscopic observation—it appears probable that knowledge of the virus will only be obtained by gradually accumulating information concerning its manner of action. From its properties we may in time construct a picture of the virus itself. This is now well recognized and is indeed basically the system of the modern bacteriologist.

The behaviour of the virus may be studied *in vitro*, in the plant and in the insect which is the natural agent of transmission from plant to plant. At present the researches at Amani are upon the virus in the plant and in the insect, and in particular upon the

streak disease virus in maize and related grasses and in the leafhopper *Cicadulina mbila*, Naude.

Streak disease was studied by the present Pathologist for several years prior to his appointment to Amani. Hence the simple facts concerning its manner of action and transmission are known. Furthermore a convenient technique for transmission experiments has been worked out. Consequently this disease is very suitable for intensive study. It has further advantages over many other virus diseases. Its signs are distinctive and are not altered by the immediate environment of the plant. The development of the disease is extremely rapid and experiments give their results quickly. The insect-vector is hardy, easily bred in captivity, and long-lived.

The lines of study of streak disease now being followed group themselves mainly around the problem of why this one species of insect, *Cicadulina mbila*, is the only transmitting agent of the virus which can be found. Extensive work, entirely negative in outcome, has been done with other insects and upon direct inoculation of the streak virus into maize. Yet certain individuals of *Cicadulina mbila* inoculate the virus with great regularity. On the other hand, some individuals of this species seem unable to take up the virus or to transmit it. This feature of insect-transmission is under study. The technique for feeding leafhoppers through membranes, devised by American workers, has been adapted to streak disease work, and is being employed for the investigation of certain aspects of this problem, including the filtration of the virus. Further studies are in progress upon the so-called incubation period of the virus in the insect, and for this work an automatic apparatus has been devised.

The virus in the plant is under study in respect of its location in and movement through the diseased plant. An investigation of its effect upon the metabolism of the plant is also projected in collaboration with the Physiologist.

The cross-transmission of streak disease between different species of the *Gramineae* has proved to be a study of great interest. A paper describing work done mainly in South Africa, in collaboration with A. P. D. McClean, is in preparation. It is proposed to continue certain lines of this work at Amani.

Comparatively little is at present known of the details of transmission of virus diseases by aphides. Although work with aphides is more difficult than with leafhoppers, it is proposed to study aphid-transmission upon lines similar to those followed with *Cicadulina mbila*. For this work the rosette disease of ground-nuts will provide suitable material.

In addition to the detailed study of selected virus diseases, work is in progress, or contemplated, to ascertain the simple facts about certain other suspected virus diseases. This is of the nature of *ad hoc* research ; and as such it is expected to be of some immediate

help in the field control of these diseases. As, however, knowledge of these diseases accumulates, it will form additional material for the more fundamental investigations for which the Station exists.

The curly-leaf disease of Cassava falls into this class. This disease is of great importance to native agriculture in East Africa. Previous work upon transmission through grafting has been confirmed. Up to the present the search for an insect vector has not been successful. When the preliminary details are worked out, it is expected that this disease of a woody dicotyledon will take a useful part in certain fundamental investigations contemplated.

## THE INVESTIGATION OF PARTICULAR CROP DISEASES.

It seems to be clear that an important contribution by the Station for the advancement of East African agriculture must be the *ad hoc* investigation at times of important crop diseases. where these investigations require equipment or time not available to Departmental Mycologists. But, with its present small staff, the Pathological Section must inevitably be faced by the conflicting claims of its fundamental research and of urgent *ad hoc* problems. Calls for assistance must come, sooner or later, at a time when the work at Amani cannot be left without serious loss. And yet, from every point of view, it is highly undesirable that such assistance should be refused. An augmentation in the staff of the section is greatly needed to permit of a satisfactory performance of this service.

An example of collaboration by the Station with an Agricultural Department is afforded by the Pathologist's visit to Nyasaland for the investigation of a problem which is primarily of immediate practical interest but probably also important from the fundamental point of view. Two months were spent in studying an obscure disease of the tea bush suspected by Dr. Butler to be a virus disease. The cause of this disease is still unknown ; but in collaboration with Mr. R. Leach, Mycologist to the Nyasaland Department, a programme of research has been drawn up and Mr. Leach will devote his time to carrying it through. This visit involved a break in the research at Amani. Nevertheless it is held to be fully justified. Dr. Butler assesses this disease as " unquestionably one of the most serious diseases to which the tea bush is liable." If its cause and means of control be found, an important step in the advancement of tea-growing in Nyasaland will have been taken.

A second *ad hoc* investigation which has been undertaken during the course of this year concerns a disease of coffee which is liable to cause serious losses in bushes which have been " stumped " in the course of regeneration of the derelict plantations in the Usambaras. The causative fungus, a *Fusarium* species, has been isolated, and a general preliminary investigation of this disease is now almost complete. Another problem which is receiving attention is the

curious leaf-curl disease of tobacco, the occurrence of which in Zanzibar and Amani was noted in the Director's report for 1928–29. The cause of this trouble is still obscure. An attack upon the problem from a physiological standpoint is in progress.

H. H. STOREY,
*Plant Pathologist.*

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## REPORT OF THE SOIL CHEMIST.

### IDEAL PROGRAMME.

A soil chemist, in addressing himself in a new country to problems of soil behaviour and soil management as the industry of agriculture encounters them, finds two general methods of approach possible. On the one hand, he may single out individual practical problems for direct experimental study, choosing his material strictly from the soils on which the problems occur, and at an early stage, after devising what possible tentative solutions he can, trying these out by comparative experiments in the field. On the other hand, he may work towards a more general command over soil problems, such as can only be afforded him by an intimate general knowledge of his soils. He will wish to study soils as they are, before facing questions involved in their use or improvement ; to learn to recognise species and varieties, and where these occur on the map and in relation to climate and other local conditions ; to find out how far existing knowledge of the inner structure and working processes of soils (mainly developed hitherto from studies of soils of temperate regions) can be taken to be true of his own material ; and to begin to fill the gaps which he will so discover in his soil-theory.

Studies of this second kind may have to proceed for a long time before any conclusions of direct industrial interest emerge from them. But they are not any the less practical in a considered sense, nor the less urgently called for by the needs of the industry. Even if far short of being ideally complete, such a groundwork of knowledge places the investigator or adviser at a great advantage over one who is set to work directly upon a problem arising in a soil to which he is in many respects a stranger. Stated in this way it appears a truism, yet the position of disadvantage is in fact occupied, perforce, by many advisory officers in soils. Their position (to draw an analogy from botanical science) is that of a botanist who, faced with prob-lems of plant pathology and plant manipulation under pressure for economic results, should find that whole branches of his subject—taxonomy, plant geography, morphology, physiology, cytology, ecology, genetics—were almost non-existent, or had never been extended to his own local plants, and had to be done without, or

patched together at odd opportunities. Soil Science has its counterparts of all these divisions, and they must be developed as necessary tools for the handling of field problems.

From the nature of their task, the soil laboratories of Departments of Agriculture must for the most part employ the first and exclude the second method of approach to their problems. Of a central research station, however, the converse is true. The aim in planning the work of the soil laboratory at Amani has been to work for results of general application, upon which the advisory services of the territories may later (possibly a long time later) base their points of departure for current field problems. Material for such studies must be sought where it may best be found, either by independent choice irrespective of immediate economic interest, or in the course of attack upon a practical problem itself. Other things being equal, the existence of a practical interest will naturally determine the choice. But in this case the urgency for a result should not have a directing influence upon the methods employed, the primary requirement being that the solution, when reached, shall have contributed something of general value to agricultural theory within the territories, and be not merely of local usefulness.

These considerations have guided the compilation of the list which follows of matters which may appropriately receive attention from this laboratory as opportunity allows. The Soil Chemist has had but short acquaintance with his material in the vast field of the six territories, and the list is correspondingly tentative and incomplete.

### 1. *General Survey and Classification.*

The examination of soils wherever encountered, noting virgin characteristics as seen in deep sections, and collecting samples from typical exposures for close comparison and simple laboratory examination. Local conditions (climate, geology, topography, vegetation) are to be recorded, and agricultural qualities to be noted if the soil is in use. The ultimate outcome of this work (combined with the results of similar work in other hands within the territories, and collated by the Imperial Bureau of Soil Science) will be a reference list of soil-types and their characters, and a soil map.

It will be understood of this work, that such a survey and classification are aimed at not merely as ends desirable in themselves, but as indispensable tools in future work. If a soil, when newly encountered, can be recognized as belonging to a type whose general properties have already been studied and are on record, the starting-point for attack upon the problems of that soil will have been materially advanced.

### 2. *Special Studies of Important Soil-groups.*

The working out, in much greater detail than for general survey purposes, of the properties of such groups of soils as the red earths of humid forest or ex-forest regions, the soils of semi-arid savannahs,

the volcanic ash soils of Kilimanjaro and Meru and of the Nakuru and Njoro districts, and the confused group of "black cotton" soils.

3. *Shifting Cultivation.*

The study of the cycle of soil changes that occurs when forest land is cleared, burnt, cultivated, cropped, and abandoned to revert—through grass and weeds, and small bush—back to forest. The virgin forest around Amani offers opportunity for an experimental lay-out, which might be designed to yield information on changes in organic matter and nitrogen supply, leaching of nutrients, soil-structure changes, effects of exposure to sun and rain-wash. Such an experiment should extend over many years, and develop ultimately into a study of long-term rotation, which is the characteristic agricultural system of tropical Africa.

Long-term rotation (under the more familiar name "shifting cultivation") has many critics, who would have the African farmer adopt more intensive methods on a permanent site, after the European model. The African, it is true, handles his native system often wastefully and unskilfully. But given at least such skill in management that the recovery of the natural vegetation is not made impossible when the cultivator leaves the site, it assures the permanence of a self-contained agriculture within a countryside (sufficiently roomy) whose population practises it. It has yet to be demonstrated that the same is true of the European system under similar conditions. It would be the object of the experiment outlined above, to ascertain some of the soil factors concerned in this important question.

Equipment for studies of drainage composition, soil temperature, etc., would appropriately be provided on the site of this permanent experimental lay-out.

4. *Manuring.*

The study of soil deficiencies by carefully planned small-scale experimentation with manures. By comparing positive and negative responses to additions of various nutrients, with chemical data, some progress may be made towards the much-to-be-desired end of predicting manurial response without manurial experiments. Meanwhile, such small scale work may indicate subject-matter for experiments with manures on a field scale under other auspices.

5. *Green Manuring.*

The principles of green manuring, such as are being worked out in relation to dry-farming, semi-humid, and humid districts in South Africa, America, and elsewhere, need establishing, particularly from the soil-nitrogen point of view, for East Africa.

6. *Erosion.*

The study of the physical properties of certain soils known to be subject to devastating erosion when their protective vegetation is

removed. It appears that some soils do, and some do not, erode rapidly when unprotected. The correlation of this property with climate and geology is not in all cases clear, and it is highly desirable to be able to predict the behaviour of a soil in an area at present undeveloped, instead of (as at present) awaiting demonstration of it after development.

7. *Regional Soil Changes.*

Large areas of country are now grassland or grassland-savannah, and are held to have been formerly forest. What soil changes, if soil changes have occurred, have favoured the non-regeneration of forest on these sites, and are they currently in progress in present-day forests or forest clearings?

8. *Manganiferous Soils.*

Soils containing manganese are locally common, and in important plantation districts. Is their manganese-content of any significance, favourable or unfavourable, in crop-husbandry?

## IMMEDIATE PROGRAMME.

Choice among the above problems for immediate work is directed by two considerations. The considerable travelling called for during the present stage of reconnaissance, or recognition of problems, will give opportunity for general survey (paragraph 1). The present small staff, and the uncertain prospects of the Station for field facilities and finance, make it impossible to embark at once upon the experimental work of paragraphs 3, 4, and 5 above, requiring as it does both expense in equipment, labour, and supervision, and assurance from interruption for a period of years. The laboratory work of paragraphs 2, 6, and 8 is therefore at present to have preference.

## EQUIPMENT.

The fabric of the new soil laboratory was completed in July, and the furniture and fittings and gas supply in December, 1929. The building, which is separate from but adjacent to the German-built chemical laboratory now occupied by the Biochemist, consists of one large and two smaller rooms, small chemical store, and soil store. It can afford bench space for at least three full-time workers, and there is some room for expansion within the building. The provision of furnishings, apparatus, and supplies for the laboratory, and of the literature of the subject in the library, is adequate for present needs, and the Soil Chemist desires to record appreciation of the facilities now available to him in these respects.

There is at present little outdoor equipment. The pot-culture house used by Eichinger in 1911–15 was dismantled and its contents

dispersed during the dark days of the Station. Renewal of this is desirable, probably on a different site.

A European assistant to the Soil Chemist (who has hitherto been single-handed) joined the staff on the 16th March, 1930.

## PROGRESS.

### (*a*) *General Survey Work.*

The amount of material yet collected is small and unrepresentative when the size of the territories which have furnished it is considered. The field data represent some 110 deep exposures minutely examined, together with notes made elsewhere from surface indications or by hurried inspection whilst travelling. The laboratory material consists of some 80 series of depth-samples representing profiles in detail, together with specimens of other kinds, the whole totalling some 480 samples. The laboratory work done upon the mass of this material does not at present extend to more than ocular inspection and the simplest routine tests, giving a record for every sample of colour, structure, approximate texture, presence or absence of concretionary bodies and of calcium carbonate, and " thio-cyanate " reaction. More detailed characterization is available for a very few samples. A number of distinct soil groups and species have already been recognised, but it is premature to decide meanwhile on the system of classification and naming to be adopted for them. The following localities are represented in the observations made :—

*Tanganyika.*—East and West Usambara highland forests, Usambara foothills, the coastal plain at Pangani, the inland plateau at points on the route Korogwe—Handeni—Kondoa—Dodoma.

*Kenya.*—Voi, Nairobi, Limuru, Uplands, Kiambu and Ruiru, Donyo Sabuk, Kinangop Plateau, many points in Uasin Gishu and Trans-Nzoia, Kipkabus, Miwani, Nandi Escarpment, Kaimaosi, Njoro.

*Uganda.*—Points near Kampala, Serere, and Mbale.

*Nyasaland.*—Tea districts near Mlanje (data and samples collected by the Plant Pathologist).

### (*b*) *Special Studies of Important Soil-groups.*

Material has been assembled and some laboratory data obtained for comparative study of the many variants of the so-called " red-earths " (actually of very varied colours) of the humid Usambara forests and foothills. A particularly interesting series of profiles was encountered in a detailed soil survey of a 90-acre estate at Tengeni—the property of the Station.

### (*c*) *Erosion.*

A field acquaintance with erosion phenomena was made during the course of a journey via Kondoa Irangi to Dodoma, in the company of the Director, to attend an informal conference on this subject

held at Dodoma in May, 1929. Material is to hand, from Kondoa Irangi and from Nyasaland, for the beginning of the work on physical properties mentioned in paragraph (6) of the research programme above.

*(d) Laboratory Methods.*

Certain analytical methods of proved usefulness elsewhere require to be examined in regard to their applicability to tropical soils. Laboratory work, since the completion of the gas plant, has been devoted chiefly to this, and it has become apparent that caution is required in the choice of methods before employing them steadily in the acquisition of results.

G. MILNE,

*Soil Chemist.*

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## REPORT OF THE BIOCHEMIST.

During the earlier part of this period, systematic work in chemistry was impossible owing to the refitting of the laboratories, including the laying of new gas and water pipes and of a drainage system throughout the building ; the Mansfield gas plant was not working until this refitting had been almost completed. Most of the time was accordingly occupied in carrying out preliminary experiments, requiring little laboratory work, of various kinds.

Experiments were carried out to find the most effective means of preserving rubber goods, particularly rubber tubing, under the tropical conditions existing at Amani. The rubber tubing was stored in various solids and liquids and results so far seem to show that in certain substances the rubber is preserved much more effectively than in air. Storing in the dark is also better than in the light.

Requests were received for information on the application of fermentation or retting methods to the extraction of Sanseviera fibre. As this is a matter of general interest some experiments were set up to try to bring about decomposition of the tissues by fermentation and by soaking the leaves in various liquids, so as to extract the fibre without using a decorticator. In the case of fermentation processes it was found that the fibre commenced to rot before the spongy tissues were sufficiently decomposed to allow the fibre to be readily removed. In the case of soaking in liquids certain of these offer promising results although the fibre becomes somewhat yellow in colour.

Preliminary work was commenced on the estimation of alkaloids in the numerous varieties of Cinchona at Amani, and on the preparation of a febrifuge of the mixed alkaloids. When the laboratories were in working order this matter was gone into in some detail and a report submitted to the Director. The amounts of the different

alkaloids in the bark of *Cinchona Ledgeriana, succirubra, robusta* and the *Ledgeriana* X *succirubra* hybrid were determined. The *Ledgeriana* trees planted some seven years ago showed good yields ; the hybrid planted at the same time showed poor yields, having largely reverted to *succirubra*. The original *succirubra* trees showed normal results whereas the *robusta* of the same date were poor.

Samples of febrifuge of the mixed alkaloids were prepared from *C. Ledgeriana* and from the hybrid ; it is hoped to have these tried as substitutes for quinine shortly. Numerous methods of extracting the alkaloids from the bark were tried with a view to finding a simple and economical method.

Extracts of the poisonous principles of certain plants used by the natives as fish poisons have been made with a view to their trial as insecticides in comparison with a standard insecticide, such as nicotine.

The Biochemist is now engaged, in co-operation with the Plant Physiologist, in designing and testing out apparatus for the rapid and accurate determination of the carbon-nitrogen ratio, for all parts of the coffee plant, in relation to its growth under varying conditions, particularly with reference to light and shade effects.

During May, June, and July, 1929, the Biochemist spent two and a half months on emergency anti-locust work, in the South Paré district of Tanganyika.

R. R. WORSLEY,
*Biochemist.*

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## REPORT OF THE PLANT PHYSIOLOGIST.

The application of Plant Physiology to agricultural problems in the Tropics is a comparatively recent development, the science itself being an essentially modern growth. Consequently it is not surprising that physiological research was not directly represented in the German establishment at Amani, and the whole furnishing and equipment of this section is therefore entirely new. Fitting up the laboratory and obtaining the necessary equipment occupied the present officer's time until August, 1929. At that date the laboratory was practically complete, and research proper was begun. Prior to that date, a considerable amount of work on the calibration of necessary instruments was carried out, and a native laboratory assistant was trained for simpler routine operations.

One of the central problems of Plant Physiology has been defined as " the elucidation of the effect on the plant of the external factors of the environment." For the proper understanding of the full meaning of this phrase the following facts must be kept in mind. First, the plant is an exceedingly complicated organism, and the

various processes which make up its metabolism are closely interrelated, i.e., any change in the rate of one process will probably affect to a considerable extent the rate of other processes ; and, secondly, the effects of the external factors on the plant are also interrelated, in that the effect produced by one factor is conditioned to a considerable extent by the intensity of the others. For example, an increase of temperature with low light intensity will not markedly increase the rate of carbon synthesis by the plant, but the same change of temperature with a high light intensity will considerably accelerate this process. It is therefore obvious that it is far from easy to interpret the effects of changing field conditions on the plant, and that it is impossible to investigate the effect of one particular factor of the environment without also studying, at the same time, the effects of others. Research must therefore be lengthy and laborious.

There are three possible methods of physiological investigation of plant growth suitable for problems awaiting attention in East Africa, two of which are being applied here.

1. The growing of plants in pot culture in the various environments to be studied, the rates of various physiological processes being recorded throughout the period under investigation. Climatic data are also collected, and at the conclusion of the experiment the mass of information accumulated is subjected to statistical analysis.

2. The study, in the laboratory, of the effect of various climatic factors on the physiological processes of plants and plant organs, under controlled conditions. Owing to the interrelationship referred to above, knowledge obtained in this way generally needs to be amplified considerably before it can be applied to the elucidation of effects produced by the rapidly changing complex of conditions obtaining in the field.

## COFFEE RESEARCH.

The main problem occupying the attention of this section is that of the effect of shade—in its broad sense—on vegetation, with especial reference to coffee. The complexity of this problem can hardly be exaggerated, involving as it does almost every branch of natural science and every function of the plant and its environment.

Work on this was started in August, 1929, when an artificial shade experiment was set up on Lion Hill, a knoll which is at all times unshaded by the surrounding forest, and where a small field laboratory has been erected. The growth of the experimental material has been and is being followed in detail since that date. Meteorological data are also available, and when the necessary apparatus is in working order the effects of the varying degrees of shade on the microclimates of the crop will be studied, as will also the rates of various physiological processes. Up to the present the shade is produced by various thicknesses of fabric, but an extension is now in hand involving the

use of slatted, i.e., discontinuous, shade which will approach normal conditions more closely. No results are of course available, but the data obtained up to the present are extremely encouraging.

A study of the effects of various high light intensities on certain functions of the plant has been started. Owing to the lack of electric current this has been interrupted but will shortly be resumed, as the preliminary data point to several interesting conclusions.

Much work has been carried out in various countries in the past on the relationship between the amounts of carbon and of nitrogen in plant tissues, and previous workers have established a correlation between the ratio of carbon and nitrogen (C/N) and fruit production; high C/N being associated with fruit production and low C/N with vegetative development. It is of interest, therefore, to know the variation of this ratio in the coffee plant throughout the year, and what value of C/N is associated with high fruit production. It is certain that shade will affect this ratio, and knowledge is needed in order to determine the optimum conditions for the establishment of the appropriate ratio at the appropriate season. This will go towards a better understanding of the problems of both under- and over-bearing in coffee. An enormous number of routine analyses will be involved, and, in collaboration with the Biochemist, a suitably rapid and accurate technique for the estimation of carbon and nitrogen in plant tissues has been developed.

## SISAL RESEARCH.

During November, journeys were made to neighbouring sisal estates, field data collected, and discussions initiated with the planters with a view to deciding on suitable objects for research on problems affecting this industry. A report was submitted to the Director. Problems of general interest are awaiting solution, many of which concern other sections, and will not, therefore, be dwelt upon here.

1. A general survey is proposed, in which an attempt will be made to correlate fibre yields and qualities with soil and climatic differences. This will necessarily be followed by an investigation of the effects of climatic conditions on sisal in a more exact and controlled manner.

2. After growing for a number of years, the sisal plant produces a " pole " or inflorescence and then dies. In East Africa this takes place after a varying number of years, some plants poling at a very early age. Nor is the number of leaves produced prior to poling constant, as has been supposed. A better understanding of the causes leading to the initiation of the fruiting stage is needed, and such a study is proposed.

3. Sisal is not infrequently propagated from suckers which are removed from the bases of older plants, and one method of regeneration is by letting the suckers remain attached to the moribund parent stems which they finally replace. Certain field observations tend to show that the influence of the parent plant on the development of the sucker can be considerable, and, as opportunity offers,

this, and the converse effect, will be studied. It is as well to emphasize that the foregoing paragraphs do not refer to work in hand, but work which is projected and will be carried out as time and facilities are available. The opening of the Sub-station at Tengeni should provide a site for experimentation on the lines laid down above, and it is hoped to start certain lines of attack in the not distant future.

F. J. NUTMAN,
*Plant Physiologist.*

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## REPORT OF THE PLANT GENETICIST.

From the beginning of the year until my appointment as Geneticist in October, 1929, the investigations in the section of genetics (plant breeding) were carried out in my capacity as Colonial Agricultural Scholar, and were chiefly confined to the coffee crop. Since my appointment the scope of my work has been extended to tea, sisal, cinchona, cover crops, and green manure plants.

Improvement in the productivity of any crop, apart from response to varied agricultural operations, is a problem which can be approached in several ways, some of which may produce good results after a comparatively short period of time, while others require much more preliminary work. The improvements with which the plant breeder is concerned relate to the inherent capacity of a plant or group of plants to produce a profitable crop regularly from a given area, without detriment to the health of the plant or excessive liability to disease or the attack of pests, under normal cultural conditions.

The methods available for bringing about such improvements are—

1. Selection of the best types from among the established species and varieties and propagation of these to replace the less profitable mixed types.

2. The introduction and trial of new varieties and the selection of those found most suitable to the conditions under which they are to be grown.

3. The combination of valuable characters from different types by hybridization.

### COFFEE.

(1) Work on the improvement of the crop by selection is necessarily being preceded by a study of the variation in plant characters occurring in the established types and by an endeavour to correlate the response of the various types to surrounding conditions.

(2) The formation of a collection of economic species and varieties is proceeding and a study is being made of varietal characteristics from the seedling stage to the mature plant as the material becomes

available. There are at present available the following species and varieties :—

*Coffea arabica* (9 varieties),
*Coffea robusta* (5 varieties),
*Coffea bukobensis*,
*Coffea canephora*,
*Coffea congensis* (hybrid ?),
*Coffea liberica*,
*Coffea excelsa*,
*Coffea liberica var. dybowskii*,
*Coffea stenophylla*.

(3) Controlled hybridization involves a knowledge of the genetical behaviour of the characters of the various species and varieties of coffee. Before much progress can be made in this direction it is necessary to establish pure lines of the species and this will take some considerable time. A start has been made, and from the fairly extensive and variable material of *C. robusta* five trees have been selected from the point of view of health, productivity, size and appearance of the bean, and these trees have been self-pollinated and seedlings raised from the selfed seed. Limited numbers only of such plants are available at present but the supply is being increased to furnish material for further selfing and selection until fixed basal types are obtained. This procedure will be followed with introduced types as the material reaches maturity.

Work on the coffee crop has included a safari in the Moshi and Arusha district, with the Plant Pathologist, to make preliminary observations on the varieties of coffee being grown in this area and to observe, as far as possible, variations in the botanical and economic characters of the plants, and the influence of the environmental conditions on the varying forms.

The bulk of the coffee grown in the above area is of one variety and it is subjected to wide variations in climatic and soil conditions. Considerable variation occurs within this variety in many characters of economic importance, some types respond to certain environmental conditions better than others ; and there is every indication that selection of plants responding to local conditions from the established type of coffee would bring about improvement in the crop in this area.

Some new varieties have been imported and in some cases show an improvement in cropping capacity, health, size and value of the produce, compared with the older type under the same conditions. Further trial of new varieties will probably indicate material more suited to certain localities than those at present being grown.

The above survey was necessarily very rapid and superficial, but much useful information was obtained indicating the lines to be followed in further work on this crop, and a more intensive study will shortly be made. Some eighteen estates were visited, ranging

in altitude from about 3,500 feet to about 5,500 feet above sea level and subject to wide variation in climatic conditions.

Seed samples of typical and abnormal types were obtained for further study and samples of parchment coffee collected from various estates for comparative purposes.

An experiment to investigate factors governing variation in yield of single trees of *C. arabica* (the Bourbon variety) in the Eastern Usambaras was seriously affected by locusts and the results obtained were, in consequence, very unreliable and merely served to indicate those factors concerned in the building up of yield which are most subject to variation.

Experimental work on the vegetative reproduction of coffee and the technique involved in the handling of coffee flowers for the successful production of self- or cross-fertilized seed is proceeding.

## TEA.

Work on tea has been confined to the introduction of varieties from Assam, Ceylon, Java, and Nyasaland. The varieties at present available were planted out in May, 1929. The plants appear very variable within the limits of the varieties and will be used as material for selection and propagation for a comparison of the characteristics and commercial value of the types extracted.

Material for the planting up of an area of tea for general experimental purposes is in the nursery.

## SISAL.

The material raised from seed obtained through the East African Sisal Growers' Association has been transplanted into a nursery from the seed beds and a preliminary study made of the variation in the characteristics of the young plants. An endeavour is also being made to secure seed production on local poling plants.

## CINCHONA.

Investigations are being made on the methods to be adopted in emasculating and pollinating Cinchona flowers. With the assistance of the Biochemist attempts are being made to self-pollinate flowers of trees having bark of a high quinine content to provide material for an analysis of the quinine content of the progeny and to compare their productivity with that of the parent type.

## COVER CROPS AND GREEN MANURES.

Seed of temporary shade plants, cover crops, and green manure plants has only been obtainable in small quantities in the majority of cases, and this seed has been planted in nursery beds for propagation and preliminary observation.

Supplies of seeds are now available for planting larger areas under field conditions for further trial and observation.

The number of species of plants for trial, for these purposes, is being extended by importation and the collection of promising local types, and information is being collected as to their respective merits under the conditions prevailing at Amani, pending the availability of further supplies for trial in other areas.

L. R. DOUGHTY,
*Geneticist.*

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## REPORT OF THE SYSTEMATIC BOTANIST.

### HERBARIUM.

The collections in the herbarium have now been completely re-arranged. The families in the Monocotyledons as well as the Cryptogams have been arranged according to Engler's System, while those of the Dicotyledons are arranged after Hutchinson's "Classification of Flowering Plants (Dicotyledons)." The latter system has been adopted on account of the probability of it being used for the flora of East Africa, a much needed regional flora which the authorities at Kew propose to commence as soon as work on the flora of West Tropical Africa is completed. Under the families, the genera and species are arranged alphabetically and examples of the latter according to the country in which they were collected, the political boundaries forming a guide.

A considerable number of the specimens are not securely mounted, a quantity are even loose between sheets of paper, and the whole of the collection is being gone through and mounted or remounted as found necessary.

Interesting material has been received for identification from the Veterinary Research Officer, Tanganyika Territory, in connection with his investigations into the value of the indigenous flora as browse and fodder plants at Mpwapwa. Collections of plants made by Mrs. Taylor and others have been identified in connection with the botanical survey of Zanzibar and Pemba. Plant identifications were also made and ecological notes supplied to a member of the staff in connection with a paper on birds in the Western Usambaras.

Seven cabinets were provided for the herbarium during the year for filing additional material, a much needed extension to the seven existing German cases.

During the year specimens to the number of 1,879 were received for identification or as donations, the following institutions contributing :—Royal Botanic Gardens, Kew ; British Museum (Natural History) ; Zanzibar Museum ; Veterinary Department, Tanganyika Territory, through the Research Officer ; Agricultural Department, Tanganyika Territory ; and the Forestry Department, Gold Coast, through the Silviculturist. Determinations on 1,506 plants have

been made and over 1,000 have been mounted and incorporated in the herbarium.

Over 1,600 duplicates have been distributed to the following institutions :—

Royal Botanic Gardens, Kew ; British Museum (Natural History) ; Imperial Forestry Institute, Oxford ; The Herbarium, Cambridge University ; Division of Botany, Pretoria ; The Zanzibar Museum ; Royal Botanic Gardens, Calcutta ; Royal Botanic Gardens, Peradeniya ; and the U.S. National Herbarium, Washington.

## FIELD WORK.

Work on the botanical survey of the Amani plantations has been continued ; during the latter part of November and beginning of December a start was made with the Soil Chemist on a botanical and soil survey of the estate at Tengeni formerly in use by the German authorities at Amani as a low-level station.

December to the middle of February was spent in the field at the request of the Government of the Tanganyika Territory on emergency anti-locust work in the Umba Steppe, north-east of the Western Usambaras, and in the Vudee Valley on the west side of the Southern Pares. Although there was no time for serious botanical investigations, specimens were obtained and notes on the vegetation of the area made whenever the opportunity occurred. After anti-locust operations had closed down, a week was spent in the last-named area making observations and collecting, but this work was very much hampered by excessive and unusually early rains.

Seeds and plants thought to be suitable as shade, and cover and green manures, as well as plants of botanical and horticultural interest, have been collected for trial at Amani.

## PROGRAMME OF FURTHER WORK.

The survey of the Amani plantations will be continued.

Botanical surveys of a preliminary nature will be undertaken on the types of vegetation met with in any area visited.

In connection with the proposed flora of East Africa, specimens in triplicate will be collected whenever possible and a set sent to Kew for study purposes.

Seeds or plants which may prove of economic importance, together with data, will be obtained for trial.

Identifications of specimens will be made with the co-operation of the Royal Botanic Gardens, Kew, in conjunction with the botanical survey of Zanzibar and Pemba, and the Veterinary Research Officer's investigations into the use of the indigenous plants of Tanganyika Territory for browse and fodder purposes.

Certain families and genera in the herbarium do not appear to be very well named. The N.O. Gramineae is an outstanding example and the specimens will be taken to England for comparison with

authentic material at Kew and the British Museum. In this connection all the material of the genus *Combretum* has been loaned to the British Museum for study purposes.

The Amani Herbarium is known to contain a number of type specimens (specimens on which the original scientific description of a species is based). In the course of the year while naming up material sent for identification 14 were found. These specimens are not written up as such ; when time permits it is proposed to go through the collections and mark them as types or co-types listing them, together with all the specimens in the herbarium that have been collected by well-known botanists such as Schimper, Peters, Engler, Stuhlmann, Busse, etc., with a view to publication, so that other workers will know where the specimens can be studied when writing up floras or monographs. This will entail a considerable amount of time on account of the very scattered botanical literature which will have to be consulted.

There are also old German collections numbering about 4,000 sheets which have still to be identified ; work on these should be undertaken at once so that they may be included in the herbarium and made available for study purposes, and duplicates, if any, distributed.

In conclusion, as no records were originally kept of the number of specimens filed in the herbarium it is proposed to make a census during the year, and a record will be kept of all material that is incorporated from time to time.

This résumé is only an outline of the work that is in hand, and it is very desirable that European assistance should be given in order to cope with the surveys, identifications, classification, and routine work of the Section.

P. J. GREENWAY,
*Botanist.*

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## ORNITHOLOGICAL INVESTIGATIONS.

These are carried out in such time as can be found outside office hours, with the assistance of certain material facilities provided by the Research Station.

Good progress has been made with working out the avifauna of the immediate neighbourhood of Amani, which is remarkably rich and of exceptional interest from the distributional point of view. Incidentally, the foundations are being laid of a small representative collection of birds, nothing of the kind being in existence in Northern Tanganyika. Thanks are due to Mr. W. L. Sclater of the British Museum (Natural History), and to Dr. V. G. L. van Someren of Nairobi, for much help in making identifications.

This systematic work is, however, regarded only as a necessary preliminary to biological studies. A beginning has been made in the collection of data bearing on ecological associations, food supply,

incubation and fledging periods, and seasonal rhythms. Except in the form of sporadic field notes very little is on record on the biology of Tropical African birds.

Advantage has been taken of local leave to carry out two small particularized studies.

(*a*) A week in the South Paré district at the height of the locust-hopper infestation (June, 1929) was devoted to ascertaining in detail the relations in that area between birds and hoppers. The conclusion reached was that the existence of the hoppers had not resulted in any marked concentration of birds to feed on them, and that the effect of the birds present in reducing the numbers of the hoppers was negligible. Since this is at variance with published observations in Uganda and in South Africa it is desirable to ascertain whether the negative results of the South Paré investigation hold good generally for Northern Tanganyika infestations or are due to seasonal causes or are entirely abnormal.

(*b*) A census of the birds maintained by 300 acres of land in European occupation in the West Usambaras was carried out over a fortnight in September, 1929. It is believed that the figures obtained are approximately correct. Very little work on these lines has been published for European areas, and, so far as can be ascertained, none whatever for the tropics. The average density of total bird population in the particular Usambara area studied was found to be about 3 birds to the acre.

R. E. MOREAU,

*Secretary and Librarian.*

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## REPORT OF THE SUPERINTENDENT OF PLANTATIONS.

The Superintendent of Plantations again took charge of the construction and maintenance work, the upkeep of roads, including the Amani-Muhesa main road, and, when the Manager of the Kwamkoro Coffee Estate left to go on leave at the beginning of February, took over the control of the Estate. The Assistant-Superintendent of Plantations went on leave at the end of October and is expected to return to his duties at the end of April.

The following is a summary of the work done under its separate headings.

### CONSTRUCTION AND MAINTENANCE.

*Gas Plant.*—The erection of the Mansfield gas plant, together with a holder of 2,000 cubic feet capacity, has been completed, and the laboratories now have gas laid on in sufficient rooms for the scientific officers to carry on their work.

*Electricity Supply.*—Work on the installation of the hydro-electric plant has been continued. Progress has been slow. Considerable difficulty has been encountered in obtaining and erecting

the poles on the extremely steep slope for carrying the heavy overhead wire. This has now been overcome by the erection, at intervals, of four angle-iron standards. The turbine, governor, and dynamo have been fixed in position, the water pipeline is complete, the transformer hut built, and the transformer fixed in position. Poles for the low tension line are ready and the line cleared for its erection. It is expected that the electricity will be available for use in the laboratories in April or May.

## LABORATORIES AND OFFICES, EQUIPMENT, ETC.

*Pathological Laboratory.*—Benches, cupboards, and tables have been made ; gas, water, and electric fittings installed.

*Chemical Laboratory.*—Two rooms have been fitted up with tables, gas and water apparatus. Two fume cupboards have been repaired, and the dark room for spectroscopic work fitted with new table and sink. One room still remains to be fitted up.

*Soil Laboratory.*—Three new concrete benches, two fume cupboards, wooden benches and tables fixed, with water and gas laid on. The store rooms have been repaired, new concrete floors put in, and shelf space provided. More table and bench space with necessary water and gas fittings are still required in two remaining rooms.

*Botanical Laboratories.*—Gas and water laid on. Sufficient bench and table space provided. Concrete balance bench made for Physiologist.

*Entomological Laboratory.*—Bench on two sides of the large room made and fixed, with water and gas laid on.

*General Office.*—New concrete floor put in inner office.

*Library and Bookbinders' Room.*—Windows and doors repaired. New shelves made. The bookbinders' room enlarged and gas laid on.

## STAFF QUARTERS.

*House* 1. *Director.*—A new ceiling put in over drawing room. Joists where necessary replaced in roof, and the whole of the roof beams treated with solignum.

*House* 4. *Biochemist.*—Kitchen and store rooms built, and drains constructed.

*House* 6. *Secretary.*—Wash-house built and concrete drains made.

*House* 15.—The erection of a new four-roomed house was commenced early in January. Work is proceeding satisfactorily. This will be ready for occupation in August.

*Clerk's House.*—A new house, built of corrugated iron and wood-lined, on a concrete base, has been built and is now occupied by the Goanese Clerk.

*Indian Fitter's House.*—The old stone-built native hospital, the woodwork of which was in a very dilapidated condition, is now under repair and alteration and will be used as quarters for the Indian fitter and Indian carpenter. It is proposed to provide a new native hospital in a more suitable and central position.

## TIMBER.

All the timber for construction and repairs has been cut from the Kwamkoro and Amani estates. A large quantity of Mvule has also been cut at Amani and stored for general use.

## ROADS AND TRANSPORT.

The roads and bridges on the estate, as well as the main road from Muhesa to Amani, have been kept in a fair state of repair. Timber for the bridges has been supplied from the Kwamkoro estate. The stone-breaking machine and Austin tractor have been fixed at a selected site on the Amani hill, a quarry opened up and stone-breaking commenced. It is hoped, as soon as transport can be spared, to commence metalling the softer sections at the bottom of the hill.

Owing to the closing down of the Sigi Railway (due to an accident) after only a few weeks' running, the transport of the Station has been done with difficulty and expense. Although the road from Muhesa to Amani, a distance of 25 miles, is good in dry weather, and practically always passable, even in the rains, difficulties are and always must be experienced in transporting heavy materials, and it is hoped that the Sigi Railway will be reopened in the near future.

## PLANTATIONS AND NURSERIES.

Plantation work has been chiefly confined to the cleaning of the coffee, Aleurites, tea, and Hydnocarpus plantations, the preparation and planting of coffee, tea, and cover crops for the Plant Breeder and Plant Physiologist, and the importation and distribution of plants and seeds. The trial plots of the Tung Oil tree, *Aleurites Fordii*, are making very slow progress. The plants at the higher elevation of 3,500 feet still remain healthy looking, but have made practically no growth, those in the second trial plot at an altitude of 2,500 feet on a lighter soil have done better and in some cases have made a foot or more growth, while those planted at the lower level, 1,400 feet, have suffered from damage from apes, and many have died out.

*Hydnocarpus wightiana* (Chaulmoogra oil) continues to do well. Young trees supplied to the Universities Mission, and planted at a lower altitude than those planted at Sigi, have commenced to fruit.

*Sisal.*—The sisal seedlings raised from the seed from the East African Sisal Growers' Association are doing well, and over 4,000 have been planted out at Sigi.

## IMPORTATION AND DISTRIBUTION.

Some 250 packets of seeds and 50 plants of fruit and other economics were imported to the station during the year. In addition, 230 lb. of *Aleurites Fordii* and 210 lb. of *Aleurites montana* were received, most of which was distributed to planters. The germination of *A. montana* was extremely poor.

Distribution was as follows :—

| | |
|---|---|
| Packets of seeds ... ... ... ... | 550 |
| Plants ... ... ... ... ... ... | 700 |
| Coffee seeds ... ... ... ... ... | 430 lb. |
| *Aleurites Fordii* and *A. montana* (from imported seed). | 400 lb. |
| Oil Palms *Elaeis guineensis* ... ... ... | 22 lb. |
| Ginger ... ... ... ... ... ... | 30 lb. |
| Bulbs ... ... ... ... ... ... | 14 Boxes. |
| Para Rubber *Hevea brasiliensis* ... ... | 2 lb. |
| China grass *Boehmeria nivea* ... ... ... | 5 Boxes. |
| Cuttings—Mixed species ... ... ... | 200 |

F. M. ROGERS,
*Superintendent of Plantations.*

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## REPORT OF THE SECRETARY AND LIBRARIAN.

### GENERAL.

In the early part of the financial year the pressure of secretarial and accountancy work remained very heavy, concerned as it was with the reconstruction as well as the maintenance of the Research Station. It was not until the arrival of the Assistant Secretary and Librarian in October, 1929, that full attention could be directed to the reorganization of the library, which had of necessity taken second place ever since the Research Station was revived.

### THE LIBRARY.

The present composition of the library reflects its history. Up to 1914 development was steady and was evidently assisted by valuable donations ; but from 1914 to 1927 its growth was almost completely checked. During this second period there were very few accessions of books and almost without an exception the series of periodicals suffered intermission. During the last two years what little has been possible out of the maintenance funds has been done to make good these deficiencies ; but the sums at the disposal of the library have been insufficient to meet more than a small fraction of the arrear demands. Hopes are held out of a substantial grant from an

external source for this purpose, and meanwhile there are signs that the numerous institutions to whom we have lately appealed for missing back numbers of their publications will make a generous response.

Even in its present state, when the effects of the intermission are still unrepaired, the library is a fine one, probably the best scientific library between Cairo and Pretoria. While German is naturally still the predominant language, the scope of the library is fully international, with representative publications in the various sciences coming within the purview of agricultural research workers from every important country in the world. Broadly, it may be said that the stock of literature accumulated by the German *Biologisches-Landwirtschaftliches Institut* meets the requirements of the present Research Station very fairly, although the outlook of the two institutions differs considerably and as a consequence the limits of their ideal libraries would not coincide.

With every year of growth following its resuscitation the library tends of course to assume proportions fitting it more exactly for the purposes it is now called upon to serve. Given assistance in making up the arrears and a reasonable annual sum for the purchase of current publications, the Amani Library should in the near future come to be a potent instrument to the hand of local scientific workers. It could take its place as the central scientific reference library for the whole of the East African Dependencies; and in this connection it may be emphasized that comparatively little difference is made to the administrative expenses of such a library, whether its users number six or sixty.

As regards the current growth of the library, the number of books received during the financial year is 61. The number is not large, but this is a class of accession that is directly dependent upon income. The series of periodicals now received number 223, including 146 on an exchange basis from 85 departments and societies all over the world. It is anticipated that these last two figures may be almost doubled during the next twelve months.

A library has only begun to perform its functions when it has accumulated the necessary documents within its four walls. It should provide that the books themselves may be readily accessible to the borrower, and that the information they contain on any given subject may be readily accessible for the enquirer. Recent work in the library has been directed with these two aims. When it was begun the position was that, while much necessary sorting of documents had been carried out, the extent of the deficiencies due to wartime neglect had been ascertained, and good progress had been made in resuming relations with other institutions, almost everything remained to be done towards putting the library as a whole on modern lines and making its contents accessible.

The form of classification to be adopted was very carefully considered. The International Decimal System was found not to be

well fitted for the particular requirements of the Research Station and was reluctantly rejected. Eventually a classification worked out on decimal lines by all the scientific officers in collaboration was adopted.

The work of recataloguing and rearranging the volumes in the library in accordance with the new system has been completed. This involved relabelling the greater part of them, a labour that has been facilitated, and with excellent final result, by the use of a Roneo printing machine.

The formidable task is now being faced of constructing a classified subject index designed to show at a glance what published matter in every form the library contains on any scientific subject that may arise. Since the new publications that are always being received must receive first attention and this form of index cannot be prepared by merely mechanical labour, it is anticipated that considerable time must elapse before the vast arrears of unindexed literature can be overtaken.

R. E. MOREAU,
*Secretary and Librarian.*

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